ML004400

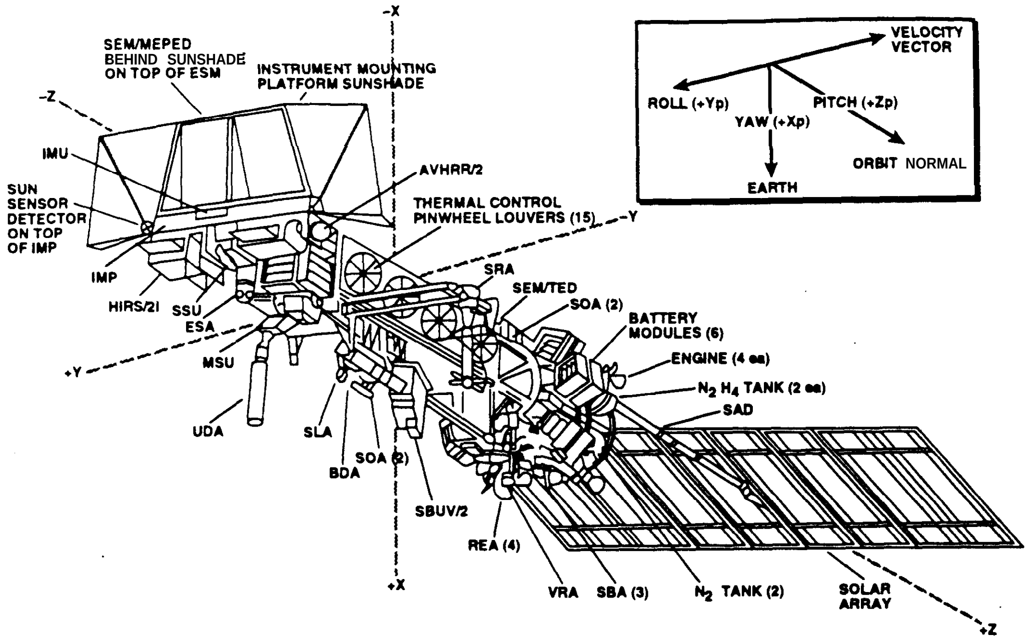
ADVANCED TIROS-N (ATN)

NOAA-J

National Aeronautics and
Space Administration

Goddard Space Flight Center
Greenbelt, Maryland

**National Environmental
Satellite, Data, and
Information Service
Suitland, Maryland**



LEGEND

AVHRR/2	Advanced Very High Resolution Radiometer
BDA	Beacon/Command Antenna
ESA	Earth Sensor Assembly
HIRS/2I	High-resolution Infrared Sounder
IMP	Instrument Mounting Platform
IMU	Inertial Measurement Unit
MSU	Microwave Sounding Unit
REA	Reaction Engine Assembly
SAD	Solar-Array Drive
SBA	S-Band Antenna
SBUV/2	Solar Backscatter Ultraviolet Spectral Radiometer
SLA	Search-and-Rescue Transmitting Antenna (L-Band)
SOA	S-Band Omni Antenna
SRA	Search-and-Rescue Receiving Antenna
SSD	Sun Sensor Detector
s s u	Stratospheric Sounding Unit
UDA	Ultra-High-Frequency Data Collection System Antenna
VRA	Very-High-Frequency Data Real-Time Antenna
SEM	Space Environment Monitor

NOAA-J Spacecraft with Major Features Identified

TIROS PROGRAM

INTRODUCTION

The Advanced Television Infrared Observation Satellite (TIROS)-N (ATN) program is an extension of the TIROS Program. The ATN provides for additional instruments such as the SAR. These are described later in this document. The program is a cooperative effort between the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA). the United Kingdom (UK), and France for providing day and night global environmental and associated data for regular daily operations. Elements of the Search and Rescue- (SAR) system are provided by Canada and France. Martin Marietta Astronautics (MMA) is the prime contractor for the Atlas launch vehicle and is under contract to the U.S. Air Force (USAF) Systems Command Headquarters-Space Systems Division, which provides launch vehicle management and launch services. The USAF Space Command, 2nd Space Launch Squadron, is responsible for flight vehicle processing and launch operations.

TIROS-N was launched October 13, 1978, at 11:23 Z into a 470-nmi orbit and was the first in the series of a fourth-generation operational environmental satellite system. TIROS-N was a research and development spacecraft serving as a protoflight for the operational follow-on series, NOAA-A through M spacecraft.* Advanced instruments measure parameters of the Earth's atmosphere. its surface and cloud cover, solar protons, positive ions, eiectron-flux density. and the energy spectrum at the satellite altitude. As a part of the series mission, the spacecraft also can receive, process, and retransmit data from Search and Rescue beacon transmitters, free-floating balloons, buoys, and remote automatic observation stations distributed around the globe. RCA/Astro Space Division (RCA/ASD) was the prime contractor for the TIROS-N spacecraft. The polar operational system consists of two satellites in Sun-synchronous orbits, one in a morning orbit at 450 nmi and one in an afternoon orbit at 470 nmi.

NOAA-A (6) was launched June 27, 1979, at 15:51:59 Z into a 450-nmi orbit. The satellite greatly exceeded its 2-year lifetime and was deactivated on March 31, 1987 after nearly 8 years of operational service.

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*Redesignated NOAA-6 through 11 after launch-Note: NOAA-B did not receive a number because it did not achieve a useful orbit due to a launch-vehicle anomaly. Therefore, NOAA-C became NOAA-7 in orbit. NOAA-D was launched on May 14, 1991, and became NOAA-12. Thereafter, the numbering is back in sequence and NOAA-I is NOAA-13 and so on.

NOAA-B was launched May 29, 1980, at 10:53 Z and failed to achieve a usable orbit because of a booster engine anomaly.

NOAA-C (7), launched June 23. 1981, at 10:52:59 Z into a 470-nmi orbit. was deactivated in June 1986 following failure of the power system.

NOAA-E (8) was launched March 28, 1983, at 15:51:59.95 Z into a 450-nmi orbit. It was the first of the ATN spacecraft and included a stretched structure which provides growth capability, and it also included the first SAR package. The redundant crystal oscillator (RXO) failed after 14 months in orbit. The RXO recovered from its failure, finally locking up on the RXO backup side in May 1985. The spacecraft was stabilized and declared operational by NOAA on July 1, 1985. The satellite was finally lost on December 29, 1985, following a thermal runaway which destroyed the battery.

NOAA-F (9) was launched December 12, 1984, at 10:41:59.8 Z into the 470-nmi afternoon orbit and is currently in standby operation. Digital Tape Recorder (DTR) 1A/1 B failed 2 months after launch. The Earth Radiation Budget Experiment (ERBE)-Scanner stopped outputting science data in January 1987. The Advanced Very High Resolution Radiometer (AVHRR) has at times exhibited anomalous behavior in its synchronization with the Manipulated Information Rate Processor (MIRP), Microwave Sounding Unit (MSU) channels 2 and 3 have failed, and the power system is degraded. A Solar Backscatter Ultraviolet (SBUV/2) instrument is also aboard, and it is operating satisfactorily. The satellite is collecting, processing, and distributing SBUV/2 and ERBE-Nonscanner (NS) data. It is also providing real-time SAR data and global SAR data via GAC data stream.

NOAA-G (10) was launched September 17, 1986, at 15:52 Z into the 450-nmi morning orbit, and it is currently transmitting data for local weather analysis directly to users around the world. The prime contractor was General Electric following the purchase of RCA, and became GE Astro Space Division (GE/ASD). All instruments and subsystems are performing well except the ERBE-Scanner, which has exhibited a scan sticking anomaly that is apparently generic to the instrument, and the SAR Processor (SARP) 406 MHz receiver, which has failed.

NOAA-H (11) was launched September 24, 1988, at 10:02:00.385 Z into a 470-nmi afternoon orbit with a 1:40 p.m. ascending node crossing time. It is currently transmitting data for local weather analysis directly to users around the world. All instruments are operational. The NOAA-H had been modified for a 0” to 80” Sun angle and includes fixed and deployable sunshades on the Instrument Mounting Platform (IMP) and the capability for a deployable Medium Energy Proton and Electron Detector (MEPED). The increase of maximum Sun angle from 68” to 80” allows an afternoon nodal crossing closer to noon to enhance data collection. Two gyros have failed, however, and attitude control is being maintained through the use of new reduced gyro flight software. In addition, before the NOAA-D launch, a gyroless flight software package was installed on NOAA- 1 1 which will provide attitude control, at expected reduced accuracy, should the X gyro fail.

NOAA-D (12) was launched into a 450-nmi morning orbit on May 14, 199 1, at 15:52:.035 Z and is functioning well. It replaced NOAA-G (10) in orbit, however, it does not contain a SAR package.

NOAA-I (13) was launched on August 9, 1993, at 10:02 Z into a 470-nmi afternoon orbit. The prime contractor was Martin Marietta following the purchase of GE/ASD, and became Martin Marietta Astro Space (MM/AS). On August 21, 1993, the spacecraft suffered a power system anomaly. All attempts to command the spacecraft since then have been unsuccessful.

The operational ground facilities include the Command and Data Acquisition (CDA) stations in Fairbanks, AK and Wallops Island, VA, the Satellite Operations Control Center (SOCC) and Central Environmental Satellite Computer System (CEMSCS) facilities in Suitland, MD, and a data-receiving location in Lannion, France. The U.S. SAR operational ground system consists of a Search and Rescue Satellite Aided Tracking (SARSAT) U.S. Mission Control Center at Suitland, MD and 14 local user terminal (LUTs) ground stations at seven sites (Fairbanks, AK; Vandenberg AFB, CA; Wahiawa, HI; Johnson Space Flight Center, Houston, TX; NOAA, Suitland, MD; Anderson AFB, Guam; and Sabana SECA, PR). The LUTs will provide coverage from the mid-Pacific to the mid-Atlantic and from the North Pole south to the Equator. In addition to U.S. SAR ground facilities, many other cooperating nations operate additional LUTs and Mission Control Centers (MCCs) of their own, and have other MCCs networked to the U.S. MCC.

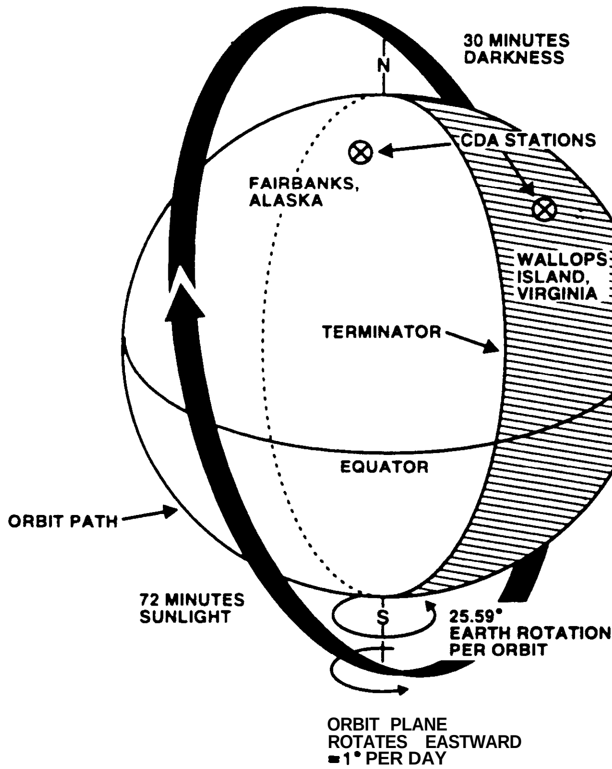
PHYSICAL CHARACTERISTICS

The physical characteristics of the NOAA-J spacecraft are—

- Main body: 4.18 m (13.7 ft) long, 1.88 m (6.2 ft) in diameter.
- Solar array: 2.37 by 4.91 m (7.8 by 16.1 ft), 11.6 m^2 (125 ft^2).
- Weight: At liftoff, 1,712 kg (3,775 lbs) on orbit, 1,030 kg (2,288 Ibs).
- Power: Orbit average end of life-593 W for gamma angle = 0°, 533 W for gamma angle = 80”.
- Lifetime: Greater than 2 years.

ORBIT

NOAA-J is a three-axis-stabilized spacecraft that will be launched into an 870-km (470-nmi) circular, near-polar orbit with an inclination angle of 98.86” (retrograde) to the Equator.



ORBITAL CHARACTERISTICS
Apogee. ... 870 km (470 nmi)
Perigee. ... 870 km (470 nmi)
Minutes per orbit 102.12
Degrees inclination 98.86

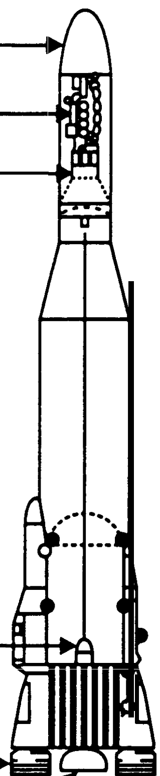
NOAA-J Orbit

The total orbital period will be approximately 102.12 minutes. The sunlight period will average about 72 minutes, and the Earth shadow time will average about 30 minutes. Because the Earth rotates 25.59” during each NOAA-J orbit, the satellite observes a different portion of the Earth’s surface during each orbit.

The nominal orbit is planned to be Sun-synchronous and precesses (rotates) eastward about the Earth’s polar axis 0.986” per day (the same rate and direction as the Earth’s average daily rotation about the Sun). The precession keeps the satellite in a constant position with reference to the Sun for consistent illumination throughout the year.

NOAA-J will be launched so that it will cross the Equator at about 1:40 p.m. northbound and 1:40 a.m. southbound local solar time.

The circular orbit permits uniform data acquisition by the satellite and efficient command control of the satellite by CD.4 stations located near Fairbanks, AK, and Wallops Island, VA.



Atlas-E Launch Vehicle

LAUNCH VEHICLE

The spacecraft will be launched from the Air Force Western Range (WR) at Vandenberg AFB, CA, by an Atlas-E launch vehicle. The standard Atlas launch vehicle consists of an E-series Atlas ballistic missile that has been refurbished and modified to a standard configuration for use as a launch vehicle for orbital missions. It is capable of launching a spacecraft into a variety of low Earth orbits. The launch vehicle is manufactured and refurbished by MMA, under contract to the USAF.

The vehicle is 28.7 m (94 ft) tall and 3.05 m (10 ft) in diameter. The fairing is 7.42 m (24.3 ft) long and 2.13 m (7 ft) in diameter. At liftoff, it carries 70 kiloliters (kL) (18,457 gal) of liquid oxygen and 43 kL (11,35 1 gal) of RP-1 fuel, a highly refined kerosene. Sea level engine data are presented in Table 1.

An airborne autopilot programmer in the launch vehicle flight control system provides preprogrammed steering and backup discrete commands. The GE Radio Tracking System (GERTS) ground station acquires the vehicle at approximately liftoff +85 seconds and performs the guidance function by means of the launch vehicle's pulse beacon decoder.

TABLE 1: Atlas-E Sea Level Engine Data

	Booster	Sustainer	Vernier
No. of Engines	2	1	2
Thrust per engine (lb)	165,000	60,000	1,000
Thrust per engine (N)	733,920	266,880	4,448
Thrust duration from liftoff (sec)	121	310	329

The vehicle is powered by one sustainer, two boosters, and two vernier engines using liquid oxygen and liquid hydrocarbon propellants. A 0.97-m (3%in) diameter attach fitting fastens the NOAA-J spacecraft to the launch vehicle. The fairing attached to the forward face of the launch vehicle protects the spacecraft during the boost flight.

APOGEE KICK MOTOR (AKM)

Apogee maneuver is accomplished by use of a Thiokol Corporation, Elkton Division, STAR 37S solid propellant motor. This 94 cm (37 in) spherical rocket motor, which has flown on all previous TJROS-N type missions to date, provides an average 42.77 kN (9,542 lbs) of thrust during a motor bum time of 43.5 seconds. The STAR 37S motor, which is attached to the NOAA-J spacecraft, remains with the spacecraft after burnout.

NOAA-J INSTRUMENTATION

The instrument systems provide both direct readout (real time) and onboard recording (playback) of environmental data during day and night operation. The NOAA-J spacecraft carries the following primary instruments *(manufacturer in italics):*

ADVANCED VERY HIGH RESOLUTION RADIOMETER (AVHRR)

ITT

The AVHRR is a radiation-detection imager used for remotely determining cloud cover and the surface temperature. This scanning radiometer uses five detectors that collect different bands of radiation wavelengths as shown in Table 2. Measuring the same view, this array of diverse wavelengths, after processing, will permit multispectral analysis for more precisely defining hydrologic, oceanographic, and meteorological parameters. One channel will monitor energy in the visible band, and another channel will monitor energy in the near-infrared portion of the electromagnetic spectrum to observe vegetation, clouds, lakes, shorelines, snow, and ice. Comparison of data from these two channels can indicate the onset of ice and snow melting. The other three channels operate entirely within the infrared band to detect the heat radiation from and hence, the temperature of land. water, sea surfaces, and the clouds above them.

TABLE 2: Advanced Very High Resolution Radiometer (AVHRR)

Characteristics	Channels				
	1	2	3	4	5
Spectral range (micrometers)	0.58 to 0.68	0.725 to 1.0	3.55 to 3.93	10.3 to 11.3	11.4 to 12.4
Detector Material	Si	Si	InSb	HgCd Te	HgCd Te
Resolution (km at nadir)	1.1	1.1	1.1	1.1	1.1
Instantaneous field of view (IFOV) (milliradians squared)	1.3	1.3	1.3	1.3	1.3
Signal-to-noise ratio at 0.5 albedo	>3:1	>3:1	-	-	-
Noise-equivalent temperature difference at (NEAT) 300K	-	-	<0.12K	<0.12K	<0.12K
Scan anqle (degrees)	±55	±55	±55	±55	±55
Optics-&in diameter afocal Cassegrainian telescope with refractive focusing optics. Scanner-360-rpm hysteresis synchronous motor with beryllium scan mirror. Cooler-Two-stage radiant cooler, infrared detectors controlled at 105 or 107 K. Data output-lo-bit binary, simultaneous sampling at 40-kHz rate.					

SOLAR BACKSCATTER ULTRAVIOLET SPECTRAL RADIOMETER, MOD 2 (SBUV/2)

Ball Aerospace

The SBUV/2 instrument is a spectrally scanning ultraviolet radiometer. Similar instruments were flown on NOAA-F, NOAA-H, and NOAA-I.

The SBUV/2 is capable of measuring solar irradiance and scene radiance (backscattered solar energy) over the spectral range 160 to 400 nanometers. The objectives of this instrument are—

- To make measurements from which total ozone concentration in the atmosphere can be determined to an absolute accuracy of 1 percent.

- To make measurements from which the vertical distribution of atmospheric ozone can be determined to an absolute accuracy of 5 percent.

- To measure the solar spectral irradiance from 160 to 400 nanometers.

TIROS Operational Vertical Sounder System (TOVS)

The TOVS system consists of three instruments: the HIRS/2I, the SSU, and the MSU. All three instruments measure radiant energy from various altitudes of the atmosphere. and the data are used to determine the atmosphere's temperature profile from the Earth's surface to the upper stratosphere. Pertinent information appears in the following sections.

Stratospheric Sounding Unit (SSU)
MATRA MARCONVUK

Temperature measurements in the upper stratosphere are derived from radiance measurements made in three channels using a pressure-modulated gas (CO,) to accomplish selective bandpass filtration of the sampled radiances. The gas is of a pressure chosen to yield weighting functions peaking in the altitude range of 25 to 50 km where atmospheric pressure is from 15.5 to 1.5 mbar, respectively. This gas is contained in three cells, one of which is located in the optical path of each channel. Table 3 summarizes the SSU instrument characteristics.

High Resolution Infrared Radiation Sounder (HIRS/2I)
ITT

This instrument detects and measures energy emitted by the atmosphere to construct a vertical temperature profile from the Earth's surface to an altitude of about 40 km. Measurements are made in 20 spectral regions in the infrared band. (One frequency lies at the high frequency end of the visible range.) Table 4 summarizes the HIRS/2I instrument characteristics.

Microwave Sounding Unit (MSU)
JPL

This unit detects and measures the energy from the troposphere to construct a vertical temperature profile to an altitude of about 20 km. Measurements are made by radiometric detection of microwave energy divided into four frequency channels as shown in Table 5. Each measurement is made by comparing the incoming signal from the troposphere with the ambient temperature reference load. Because its data are not seriously affected by clouds, the unit is used along with the HIRS/2I to remove measurement ambiguity when clouds are present.

TABLE 3: Stratospheric Sounding Unit (SSU)

Characteristics	Channels		
	1	2	3
Spectral range(cm^{-1})	669.99	669.63	669.36
Equivalent bandwidth (cm-')	**2.0**	1.0	0.4
Detector	TGS* Pyroelectric	TGS* Pyroelectric	TGS* Pyroelectric
Resolution (km at nadir)	147.3	147.3	147.3
IFOV (degrees) circular	10	10	10
NEΔT at 273 K	0.25	0.5	1.25
Scan width from nadir (degrees)	±40	±40	±40
Weighting function peak (atmospheric pressure in mbar)	**15**	**5**	**1.5**
Optics — No collecting optics, 2-in aperture. Scanner — 10° stepper for 360° when in automatic calibration mode. Data output — 12-bit binary sampled at 0.48-kbps rate.			

. TGS = triglycine sulfate

Space Environment Monitor (SEM)
LORAUNOAA SEL

The SEM is a multichannel, charged-particle spectrometer that measures the population of the Earth's radiation belts and the particle precipitation phenomena resulting from solar activity (both of which contribute to the solar/terrestrial energy interchange). The SEM consists of two separate sensor units and a common DPU. The sensor units are the TED and the MEPED. The lower-energy sensors (TED, plus the proton and electron telescopes of MEPED) have pairs of sensors with different orientations because the direction of the particle fluxes is important in characterizing the energy interchanges taking place.

Objectives:

- To determine the energy deposited by solar particles in the upper atmosphere.
- To provide a solar storm warning system.

TABLE 4: High Resolution Infrared Radiation Sounder (HIRS/2I)

Characteristics	Channels		
	1-12	13-19	20
Spectral range (micrometers)	6.72-14.95	3.76-4.57	0.69
Detector	HgCd Te	InSb	Si
Resolution (km at nadir)	20.4	20.4	20.4
IFOV (Milliradians)	24	24	24
(NEΔN)	0.03 to 0.96	0.003 0.0002 to 0.001	—
Scan width from nadir (degrees)	±49.5	±49.5	±49.5

Optics--5.9.in diameter Cassegrainian telescope.
Scanner-1.8” stepper, 56 scan steps then retrace.
Cooler-Two-stage radiant cooler, infrared detectors controlled at approximately 105 K.
Data output-13-bit binary, channels sampled sequentially at 2.88-kbps rate.

TABLE 5: Microwave Sounding Unit (MSU)

Characteristics	Channels			
	R_1	R_2	R_3	R_4
Frequency (GHz)	50.30	53.74	54.96	57.95
RF bandwidth (MHz)	220	220	220	220
Resolution (km at nadir)	105	105	105	105
NEAT (K)	0.3	0.3	0.3	0.3
Dynamic range (K)	O-350	O-350	(r-350	O-350
Scan width from nadir (degrees)	±47.4	f47.4	f47.4	f47.4
Antenna beamwidth (degrees)	7.5	7.5	7.5	7.5
Antenna beam effitency (%)	>90	>90	>90	>90

Optics—Two scanning reflector antennas.
Scanner-9.5” stepper through 360° scan.
Data output—12-bit binary at a 0.32-kbps rate.

Technique:

- ☐ TED cylindrical electrostatic analyzer and spiraltron.
- ☐ MEPED solid-state detector telescopes and omnidetectors.

Electrical characteristics:

- ☐ Logarithmic digital data and 32-sec subcommutation of housekeeping in two B-bit words per minor frame.
- ☐ Twelve commands.
- ☐ Fifteen analog housekeeping parameters.
- ☐ Fifteen digital discrete telemetry functions.

Performance:

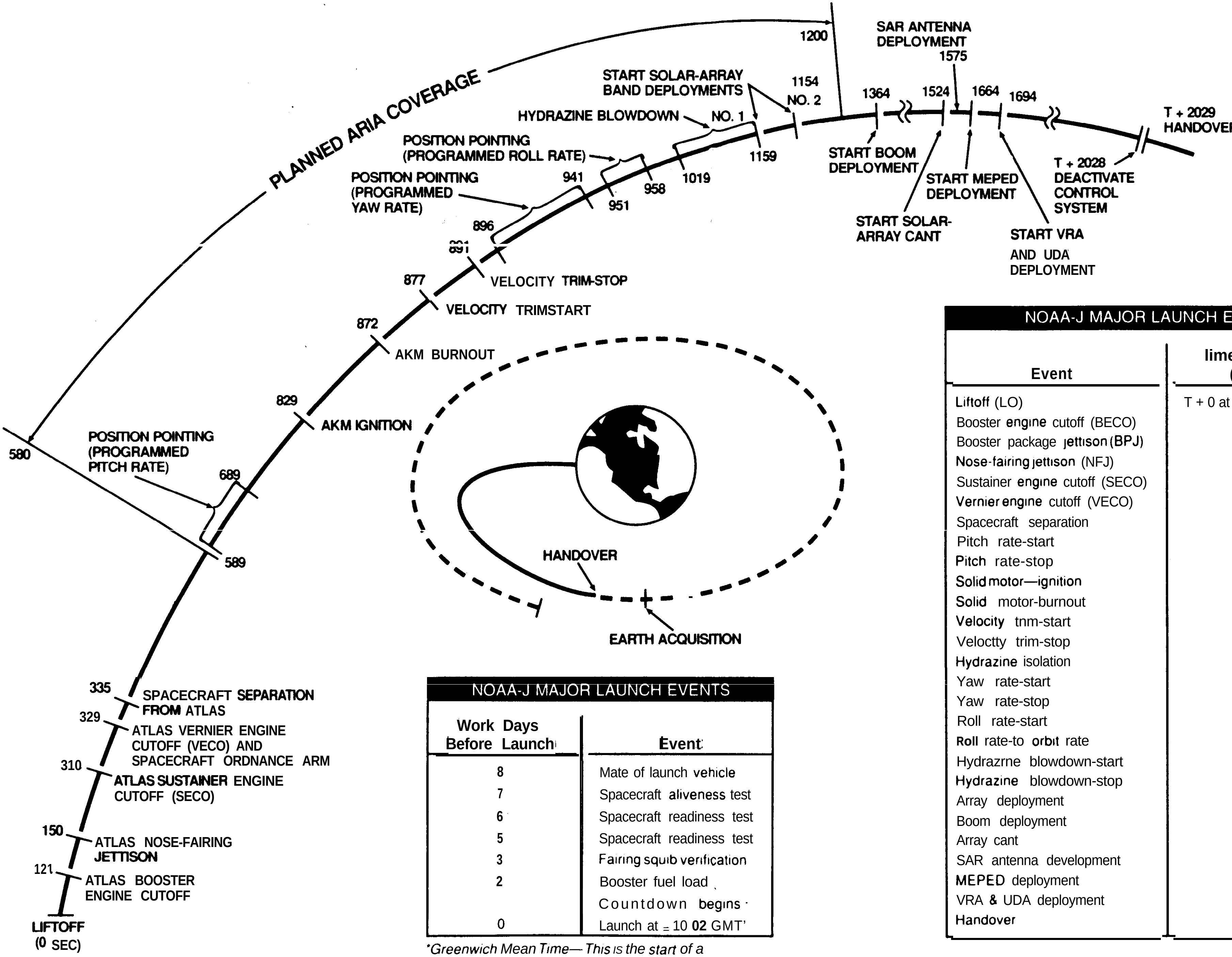
☐ TED:	Proton:	0.3 to 20 keV in 11 bands.
	Electron:	0.3 to 20 keV in 11 bands.
☐ MEPED:	Proton:	30 to 2,500 keV in 5 bands.
	Electron:	>30 to >300 keV in 3 bands.
	Ions:	>6 MeV.
	Omniproton:	>16 MeV, >36 MeV, >80 MeV.

SEARCH AND RESCUE (SAR) INSTRUMENTS

SAR REPEATER (SARR) *CRC/Canada*

SAR MEMORY (SARM) *CNES/France*

The SAR instruments consist of a 3-band (12 1 .5, 243, and 406.05 MHz) repeater SARR and a 406.025-MHz processor SARM. The SARR down link is at 1544.5-MHz and, besides the three repeated bands, also includes the 2,400 bps bit stream SARM output. MM/AS provided the antennas and interfaces and integrates the SARR and SARM into NOAA-J. The 121.5- and 406-MHz bands are also serviced by Russian COSPAS satellites which, together with the NOAA satellites, provide improved timeliness of response.



NOAA-J MAJOR LAUNCH EVENTS

Work Days Before Launch	Event
8	Mate of launch vehicle
7	Spacecraft aliveness test
6	Spacecraft readiness test
5	Spacecraft readiness test
3	Fairing squib verification
2	Booster fuel load
	Countdown begins
0	Launch at = 10 02 GMT*

Greenwich Mean Time— This is the start of a 10-minute window

NOAA-J MAJOR LAUNCH EVENTS

Event	lime from Liftoff (seconds)
Liftoff (LO)	T + 0 at 10:02 GMT
Booster engine cutoff (BECO)	121.5
Booster package jettison (BPJ)	124.6
Nose-fairing jettison (NFJ)	150.0
Sustainer engine cutoff (SECO)	310.5
Vernier engine cutoff (VECO)	329.6
Spacecraft separation	335.6
Pitch rate-start	589 3
Pitch rate-stop	689.3
Solid motor—ignition	829.2
Solid motor-burnout	872.7
Velocity tnm-start	877.7
Veloctty trim-stop	891.3
Hydrazine isolation	891.8
Yaw rate-start	896.3
Yaw rate-stop	946 3
Roll rate-start	951.3
Roll rate-to orbit rate	958.3
Hydrazrne blowdown-start	1019 3
Hydrazine blowdown-stop	11593
Array deployment	11593
Boom deployment	1364.3
Array cant	1524.3
SAR antenna development	1564.3
MEPED deployment	1664 3
VRA & UDA deployment	1694.3
Handover	2029.3

Liftoff To Handover Launch Sequence

The 121.5 and 243-MHz bands service emergency beacons that are required on many aircraft, with a smaller number carried on maritime vessels. The 406-MHz band presently services the US fishing fleet. which is required to carry emergency beacons. and large international ships, which soon will be required to carry them. They are also carried by private vessels. The beacons also are carried by some aircraft and smaller vessels and are being used by terrestrial carriers.

The 406-MHz emergency beacon signals are processed and stored on board the satellite, and transmitted to the ground from a continuous memory dump, providing complete worldwide coverage. Around the world, ground stations (LUTs) acquire the processed data and unique beacon identification, locate the beacons by Doppler signature analysis, and send these located and identified alerts to MCCs which forward the alerts to appropriate Rescue Coordination Centers for action. The 406-MHz beacons are designed to work well with the satellite, and the system nominally provides better than 4-km accuracy, 95 percent ambiguity resolution on first pass, and better than 90 percent location probability on one pass.

The 12 1.5/243-MHz emergency beacons, whose use predates the satellite system, have not been specified to work with the satellite; consequently the results are variable, depending on the quality of the beacon. Nominally, location accuracy is about 20 km. Because the satllite does not store 121.5/243-MHz data, the beacons will be detected only if they are in view of a satellite when the satellite is within view of a LUT. No identification is included with the 12 1.5/243-MHz transmissions; consequently, many non-beacon sources are also detected as beacons, increasing the difficulty of using these alerts. Even with these problems, the large number of these beacons in the field have provided an impressive performance history. More than 3,600 people have been saved by the SAR forces worldwide using satellite-derived locations.

ARGOS/DATA COLLECTION SYSTEM (DCS)

CNES/France

The ARGOS/DCS assists NOAA in its overall environmental mission. Platforms (buoys, free-floating balloons, and remote weather stations) collect relevant data and transmit them to the satellite. The onboard DCS receives the incoming signal, measures both the frequency and relative time of occurrence of each transmission, and the spacecraft retransmits these data via the CDA stations through SOCC to the central processing facility. The DCS information is decommutated and sent to the ARGOS processing center where it is processed, distributed, and stored on magnetic tape for archival purposes. The NOAA-I and J series DCS data rate has increased to 1,200 bits per second.

Characteristics of the DCS are—

- System Specifications:
  - ⇒ Minimum platform/satellite elevation angle of visibility . . . . 0”
  - ⇒ Number of platforms requiring location/velocity and four sensor channel, within the satellite visibility circle 520
  - ⇒ Percentage of platforms with four good Doppler measurements per day . . . . >85 percent
  - ⇒ Measured location accuracy 350m
  - ⇒ Data bits available . . . . 32 to 256
- Platform
  - ⇒ Nominal frequency emitted . . . . 401.65 MHz
  - ⇒ Oscillator stability drift (15 minutes) . . . . 0.5×10^{-9}/min
  - ⇒ Jitter . . . . 2×10^{-9}
  - ⇒ Power emitted . . . . 1 to 5 W
  - ⇒ Message
    - Repetition Rate . . . . 90 seconds for location, and >200 seconds for data collection
    - Coding: biphase . . . . ±1.1 iO.l rad
    - Bit rate . . . . 400 bps
- Satellite
  - ⇒ Receiver
    - Noise fac tor . . . . 3 deciBels (dB)
    - Bandwidth . . . . ±12 kHz
  - ⇒ Data Recovery Units
    - Number 4
    - Frequency measurement accuracy . . . . 350 mHz rms
    - Time tagging accuracy . . . . better than 1 millisecond (ms)
  - ⇒ Interface to satellite telemetry system periodically interrogated buffer, average-bit rate . . . . 1,200 bps

COMMUNICATIONS AND DATA HANDLING

The communications subsystem uses 10 separate transmission links to handle communications between the satellite and the ground stations. Table 6 summarizes the communication links.

Communications and data handling characteristics are—

- ◻ TIROS Information Processor (TIP):
  - ⇒ Flexible low-rate data formatter and telemetry processor.
  - ⇒ Boost, orbit, and dwell modes.
  - ⇒ 8,320 bps (orbit).
  - ⇒ 16,640 bps (boost).

- ◻ MIRP:
  - ⇒ High-rate data formatter and processor.
  - ⇒ Performs multiplexing, formatting, resolution reduction, and geometric correction functions.
  - ⇒ Analog Automatic Picture Transmission (APT): Global Area Coverage (GAC) data (66.54 kbps); High-Resolution Picture Transmission (HRPT) data (665.4 kpbs); Local Area Coverage (LAC) data (665.4 kbps) outputs.

- ◻ DTR:
  - ⇒ Five digital data recorders.

HIGH RESOLUTION RADIOMETRY

One of the objectives of high-resolution radiometry is to provide timely day and night sea-surface temperature and ice, snow, and cloud cover information to diverse classes of users. The AVHRR is used to obtain these data. Requirements include—

- ◻ Worldwide direct readout to ground stations of the APT class, at low resolution (4 km).

- ◻ Worldwide direct readout to ground stations of the HRPT class (l-km resolution).

TABLE 6: Communications and Data Handling

Link	Carrier Frequency	Information Signal	Baseband	Modulation	Subcarrier Frequency
Command'	146.56 MHz	Digital commands	1 kbps	Ternary frequency-shift keyed (FSK/AM)	8,10, and 12 kHz
Beacon	137.77 and 136.77 MHz	HIRS, SSU, MSU. SBUVM SEM. DCS data, spacecraft attitude data, time code, housekeeping telemetry, memory verification, all from TIP	8.320 bps	Split-phase phase-shift keyed (PSK)	
VHF real time	137.50 and 137.62 MHz	Medium-resolution video data from AVHRR	2 kHz	AM/FM	2.4 kHz
S-band real time	1.698 or 1,707 MHz	High-resolution video and TIP data	665.4 kbps	Splrt-phase PSK	
S-band playback	1,698, 1,702.5, or 1,707 MHz	High-resolution AVHRR data from MIRP, medium-resolution AVHRR data from MIRP; all TIP outputs	2.6616 Mbps	Random ized nonreturn-to-zero/PSK	
Data collection (uplink)	401.54 MHz	Earth-based platforms and balloons	400 bps	Split-phase PSK	
S-band playback to European ground station	1.698, 1.702.5, or 1,707 MHz	TIP data recovered from tape recorders	332.7 kbps	Splrt-phase PSK	
S-band contingency and launch	2.247.5 MHz	Boost during ascent and real-time TIP in orbit	Boost 16.64 kbps TIP in orbit 8.32 kbps	Split-phase PCM/BPSK	1,024 MHz
SAR L-band downlink	1,544.5 MHz	Data transmission from SARR and SARP to ground LUTs	250 kHz	PM 2 rad peak	
SAR uplinks	SARR 121.5 MHz 243 MHz 406.05 MHz SARP 406.025 MHz	From ground ELT/EPIRBs/PLBs to spacecraft	(video) 25 kHz for 121.5 MHz 45kHz for 243 MHz 400 bps for 406 MHz	PM for 121.5/243 MHz FM for 406 MHz	

' Uplink to the satellite

- GAC data at relatively low resolutions (4 km) for central processing
- LAC data from selected portions of each orbit at high resolution (1 km) for central processing.

DATA TRANSMISSION

The sounder system data along with radiometry data will be telemetered through the TIP telemetry system on NOAA-J. Data will be transmitted at full resolution in the following modes:

- Worldwide direct TIP data transmission (beacon link).
- Worldwide direct TIP data multiplexed with HRPT.
- TIP data multiplexed with low-resolution AVHRR data stored and played back GAC.
- TIP data multiplexed with full-resolution AVHRR data stored and played back LAC.
- TIP-only data stored and played back during blind orbits.

COMMAND

The CDA stations control the operation of the satellite by programmed commands transmitted to the satellite on a 148-MHz radio signal. The following is a list of command characteristics:

- Command-link bit rate: 1,000 bps.
- Stored commands.
    - ⇒ Table capacity: 1,800 commands at launch and on orbit. (Table capacity reduced to accommodate the new MACRO command capability.)
    - ⇒ Time tag: 1 .O-second granularity, 36-hour clock.

GROUND SYSTEM

A principal operating feature of the ATN system is the centralized remote control of the satellite. through the CDA stations. by the NOAA National Environmental Satellite Data and Information Service (NESDIS) SOCC. The ground system is made up of the Polar Acquisition and Control System (PACS) and the central processing system. designated the CEMSCS. The SAR ground system consists of LUTs and MCCs.

NATIONAL ENVIRONMENTAL SATELLITE DATA AND INFORMATION SERVICE (NESDIS) SATELLITE OPERATIONS CONTROL CENTER (SOCC)

The central operations and control center for satellite operations is located at Suitland, MD. SOCC is responsible for operational control of the entire ground system and for the following areas:

CDA Stations-The primary command and data acquisition stations are located at Fairbanks, AK and Wallops Island, VA. Through a cooperative agreement between NOAA/NESDIS and the Etablissement d'Etudes et de Reserches Meteorologiques (EERM) in France, real-time TIP data can be relayed from the Lannion Centre de Meteorologie Spatiale (CMS) via a data link provided by NOAA in the United States.

The CDA stations transmit command programs to the satellite and acquire and record meteorological and engineering data from the satellite. All data are transmitted between CDA and Suitland via commercial communications links. Commands are transmitted between SOCC and CDA via commercial communications links.

Ground Communications-The ground communications links for satellite operations are provided by the Satellite Communications Network (SATCOM) and NASA Communications Network (NASCOM). NASCOM provides any launch-unique communications links for satellite launch. This support is defined in the Network Operations Support Plan (NOSP) and the NASA Support Plan (NSP). SATCOM provides all voice and data links between the SOCC and the CDA stations after launch. SATCOM is provided and operated by NESDIS.

NESDIS Central Environmental Satellite Computer System (CEMSCS)—CEMSCS acquires data from the CDA stations via SOCC and is responsible for data processing and the generation of meteorological products on a timely basis to meet the TIROS program requirements. NOAA provides all hardware and software for CEMSCS. NOAA will provide ephemeris data and strip out SAR data from MIRP/GAC data dumps and transmit them to U.S. and Canadian SAR MCCs (pre-NOAA-H only).

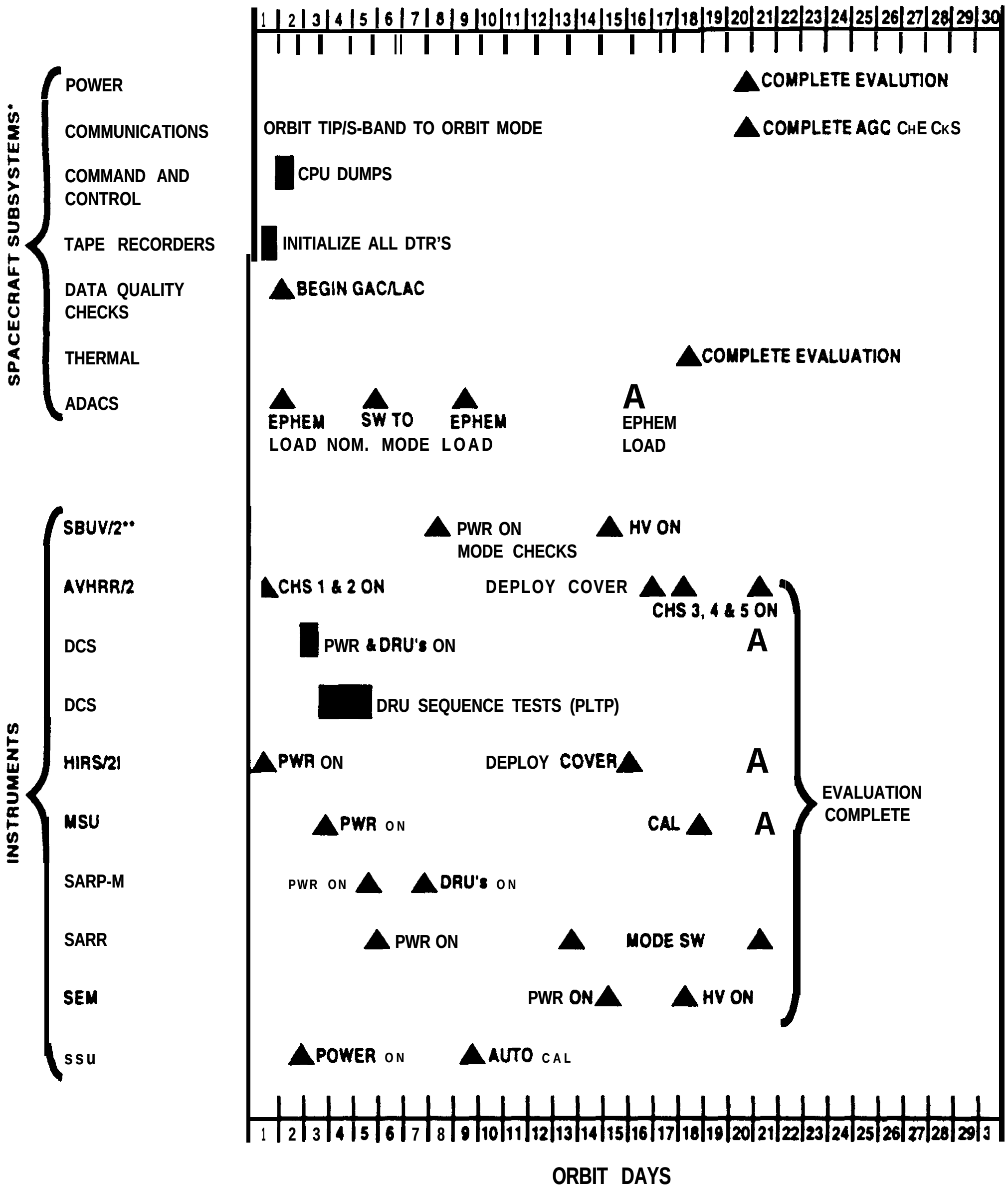
SAR Ground System (LUTs and MCCs)—The U.S. LUTs are located at Fairbanks, AK; Vandenberg AFB, CA; Wahiawa, HI; Johnson Space Flight Center, Houston, TX; NOAA, Suitland, MD; Anderson AFB, Guam; and Sabana SECA, PR. The LUTs receive the SAR data from the satellite, determine the distress location, and forward the data to the MCC at Suitland, MD. The MCC determines the proper Rescue Coordination Center and forwards the distress location data after removing redundant information. There are also MCCs and LUTs in Canada, France, Russia, and ten other cooperating countries. All MCCs cooperate in forwarding data to provide rapid global delivery of distress locations received through the satellites.

GSFC Facility Support—The Office of Space Communications (OSC) associated support is requested through the Support Instrumentation Requirements Document (SIRD), with other support as described in Memoranda of Understanding.

During launch and early orbit (approximately 24 hours), special VHF support for telemetry reception and contingency commanding is being provided by Santiago, Chili, on an as-available and best-effort basis. Santiago is required to provide emergency support for TIROS spacecraft if requested during their operational lifetime, provided NASA funding for site support continues.

The North American Air Defense Command (NORAD) has prime responsibility for orbit determination, which includes establishing the initial orbit solution and providing updated orbital parameters routinely throughout the life of the mission. NORAD provides the orbital information through the NASA/Goddard Space Flight Center (GSFC) communications to NOAA/SOCC. NASA/GSFC provides nominal prelaunch orbital and prediction information, special support for initial orbit estimation, and initial quality-control checks of the NORAD orbital data. All ground attitude determination is to be accomplished by the NOAA central data processing facility.

Launch and Contingency Downlink-An S-band downlink operating at 2,247.5 MHz is used during satellite ascent to recover TIP boost telemetry through WR tracking sites and the Advanced Range Instrumentation Aircraft (ARIA). During in-orbit operations, orbit mode TIP will be available on this link to provide early-orbit and contingency support through the ground tracking network operated by the Air Force Satellite Control Network (AFSCN) in Sunnyvale, CA.



'Subsystem baseline evaluation and operational configuration complete on Day 4.

**SBUV/2 - Completion of SBUV: bad flex memory Day 35; open lamp assembly Day 40: begin wavelength calibration Day 47; checkout complete Day 52.

NOAA-J Activation and Evaluation Timeline

GLOSSARY

ADACS	Attitude Determination and Control Subsystem
AFSCN	Air Force Satellite Control Network
AKM	Apogee Kick Motor
AM	Amplitude Modulation
APT	Automatic Picture Transmission
ARGOS	French Data Collection System
ARIA	Advanced Range Instrumentation Aircraft
ATN	Advanced TIROS-N
AVHRR	Advanced Very High Resolution Radiometer
BASD	Ball Aerospace Division
bps	Bits Per Second
BPSK	Biphase Shift Key
Cd	Cadmium
CDA	Command and Data Acquisition
CEMSCS	Central Environmental Satellite Computer System
CHS	Channels
cm	Centimeter(s)
CMS	Centre de Meteorologie Spatiale
CNES	Centre National d'Etudes Spatiales
CRC	DOC Communications Research Center
dB	DeciBel(s)
DCS	Data Collection System
DOC	Department of Communications (Canada)
DPU	Data Processing Unit
DRU	Data Recovery Unit
DTR	Digital Tape Recorder
EERM	Etablissement d'Etudes et de Reserches Meteorologiques
ELT	Emergency Locator Transmitter
EPHEM	Ephemeris
EPIRB	Emergency Position Indicating Radio Beacon

ERBE	Earth Radiation Budget Experiment
ERBE-NS	Earth Radiation Budget Experiment-Non Scanner
FM	Frequency Modulation
FSK	Frequently Shift Keyed
ft	Feet
GAC	Global Area Coverage
gal	Gallon(s)
GE-ASD	General Electric-Astro Space Division
GERTS	General Electric Radio Tracking System
GHz	Gigahertz
GOES	Geostationary Operational Environmental Satellite
GSFC	Goddard Space Flight Center
Hg	Mercury
HIA	Herzberg Institute for Astrophysics
HIRS	High Resolution Infrared Sounder
HRPT	High Resolution Picture Transmission
HV	High Voltage
IFOV	Instantaneous Field of View
IMP	Instrument Mounting Platform
In	Indium
In	Inches
ITT	International Telephone and Telegraph
K	Kelvin temperature in degrees
kbps	Thousand bits per second
keV	Kiloelectronvolts
kg	Kilogram(s)
kHz	Kilohertz
kl	Kiloliter(s)
km	Kilometers
LAC	Local Area Coverage
lb	Pound(s)
LUT	Local User Terminal
m	Meter(s)
MARCO	Command System for Space Test Program Instruments
MCC	Mission Control Center
MEPED	Medium-Energy Proton/Electron Detector
MeV	Megaelectronvolt(s)

mHz	Megahertz
mHz	Millihertz
min	Minute(s)
MIRP	Manipulated Information Rate Processor
MM/AS	Martin Marietta Astro Space
MMA	Martin Marietta Astronautics
ms	Millisecond(s)
MSU	Microwave Sounding Unit
N	Newton
NASA	National Aeronautics and Space Administration
NASCOM	NASA Communications
NEAT	Noise Equivalent Radiance
NESDIS	National Environmental Satellite Data and Information Service
nm	Nanometer(s)
NOAA	National Oceanic and Atmospheric Administration
NOM	Nominal
NORAD	North American Air Defense Command
NOSP	Network Operations Support Plan
NRC	National Research Council
NSP	NASA Support Plan
OSTDS	Office of Space Tracking and Data Systems
PACS	Polar Acquisition and Control Subsystem
PCM	Pulse Code Modulation
PLB	Personal Locator Beacon
PLTP	Platform Test Procedure
PM	Phase Modulated
PSK	Phase Shift Keyed
RCA/ASD	RCA Astro Space Division
RXO	Redundant Crystal Oscillator
SAR	Search and Rescue
SARM	SAR Processor with Memory
SARR	SAR Repeater
SARSAT	Search and Rescue Satellite Aided Tracking

SATCOM	Satellite Communications Network
Sb	Antimony (Stibium)
SBUV	Solar Backscatter Ultraviolet Radiometer
sec	Second(s)
SEL	Space Environmental Lab
Si	Silicon
SOCC	Satellite Operations Control Center
SSU	Stratospheric Sounding unit
SW	Shortwave/Switch
Te	Tellurium
TED	Total-Energy Detector
TGS	Triglycine Sulfate
TIROS	Television Infrared Observation Satellite
TIP	TIROS Information Processor
TOVS	TIROS Operational Vertical Sounder
UDA	Ultra High Frequency Data Collection System Antenna
UK	United Kingdom
USAF	U.S. Air Force
VHF	Very High Frequency
W	Watt(s)
WOMS	NESDIS CDA Station, VA
WR	Western Range